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FABRICATION AND EVALUATION OF MECHANICAL PROPERTIES OF BERMUDA GRASS ROOT FIBER/POLYESTER COMPOSITES

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ABSTRACT

Bermuda grass root fibers were comprehensively characterized to access their potential as reinforcement materials in polymer composites. An experimental study has been conducted to investigate the mechanical properties of polymer composites made by reinforcing Bermudagrass root fiber as a new natural fiber as a polyester resin. The fiber is extracted from retting and manual process. The fibers were alkali treated using NaOH solutions of various concentrations and subjected to single fiber testing. To fabricate the polymer composites, bermudagrass root fiber and polyester resin were used as reinforcement and matrix respectively. The test specimen is prepared as per ASTM standard to study the tensile and impact behavior. The tensile and impact strength value increases to a certain threshold value with increase in the fiber volume fraction and later decreases. The tensile strength and impact strength was obtained maximum for 25% fiber loading.

KEYWORDS: Bermuda Grass Root Fiber, Polyester & NaOH

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Original Article

INTRODUCTION

The Renewable resources include a surprising range of materials in which Natural fiber composites play a much -pivoted role. With the advancement in Technology, one has to restrict the development causing insecurity to the environment. To protect our environment, the concept of renewable materials has now become a key importance. Bio-fibers like coir, bamboo, jute, sisal etc are finding their place in industrial applications. A sudden outbreak in the field of biomass research in regards to the analogous properties of using synthetic fiber-polymer composites. The increase in the usage of these composites is commonly found in the interior applications of the automotive industry (Harish, 2009).

In several polymer composites, the reinforcement materials are focused on either natural fiber such as bamboo, coir, jute, hemp, sisal in their natural form or in waste cellulosic products like wood flour, rice husk, and pulp. Quite a lot of researchers have stated the behaviors of featuring the fiber in various matrices by considering chemical treatments in natural fiber composites (2-6). By chemical promotion of a good adhesion in matrix and fiber, the mechanical behaviors can be enhanced in natural fiber polymer composites. Further advantages of using naturally available fibers relate to their good production rate, low cost, easy to manufacture, safer working conditions and easily recycled. These fibers have an exceedingly upbeat environmental influence due to the fact that they are renewable and biodegradable. Hence natural fibers signify as an attractive choice for traditional synthetic fibers (Wang, 2009).

A huge number of research articles have been available on a range of biobased natural fiber and their composites. This current study is to introduce a new natural fiber and its use as reinforcing the material in the manufacture of lightweight composite structures.

Bermuda grass is an abundant fast growing and tough grass found in warm climates. Its scientific name is Cynodon dactylon. The blades are grey- green color and are short (2-15 cm), but it has a deep root system which can grow to over 2m deep. This grass has a very intensive root system and a good tolerance capacity. Due to its rapid growth, Bermuda grass is easily available throughout the year. The main characteristics of this grass are that it's very persistent and aggressive vegetation world over. The roots of Bermuda grass have a good bonding and tensile strength (Noorasikin, 2016).

The purpose of this research work is to learn the fiber of Bermuda grass root, extraction and treatment in a natural way and using these root fibers as reinforcement in the Polyester resin matrix. The different volume percentage of fiber and resin were fabricated, analyzed and illustrated to study their mechanical behaviors.

EXPERIMENTAL PROCEDURE

Materials and Methods

The Bermuda grass was gathered from a local ranch near Karur, Tamilnadu, in Southern India. These grasses are easily available and removed by using water retting process. The roots are separated from the stem and retting process allows the root fibers to detach from the woody center. Water retting creates homogenous superior value fibers. Consequently, the roots are submerged in a water tank for one to two weeks and then cleaned completely and each Bermuda grass root fiber is extracted using a roll-out machine. To remove excess moisture, these fibers are sun-dried for a few days. The matrix material considered in this work Unsaturated Polyester resin is purchased from Sun chemicals, Coimbatore.

Alkaline Treatment

After the cleaning of Bermuda grass root fiber with water, it is chemically treated using the solution of Sodium hydroxide (NaOH). The solution concentration was varied as 5, 10, 15, 20% and their effect in the immersed fibers was noted. The Bermuda grass root fiber and soaking solution are kept at a ratio of 1:10.

Single Fiber Tensile Test

The tensile properties of Single Bermuda grass root fiber before and after alkaline treatment is done based on ASTM D3822 using an INSTRON micro-tester. The gauge length of fiber is set at 50mm and a load of 2kN applies while testing. The speed of the crosshead is held at 1mm/min for the whole testing process. The average of 25 samples tensile strength and elongation was noted. A digital optical microscope, which indicated the fiber diameter leads to calculate breaking tendency.

Composite Fabrication

The Bermuda grass root fiber polyester composites were made, by altering the polyester matrix to review the capacity of reinforcing Bermuda grass root fibers. For the curing process, 1.5% of Methyl ethyl ketone peroxide accelerator and Cobalt octoate catalyst is added to the resin. The fibers and resin were compressed and molded by means of

Compression molding machine at 80° C for 30 min and allowed to cure at room temperature for 2 to 3 hours. The samples were set with five various volume percentage of Bermuda grass root fiber with fiber volume fractions 10, 20, 30, 40 and 50%.The consigned levels of input factors for fabricating Bermuda grass root fiber reinforced polyester composites are shown in Table 1

Table 1: Selection of Parameters and their levels

Level	Fiber content (%)	Resin content (%)	Sample No.
Very low	10	90	1
Low	20	80	2
Medium	30	70	3
High	40	60	4
Very high	50	50	5

Tensile Testing

The tensile behavior of the Bermuda grass root fiber reinforced polyester composites were incised as per ASTM D3039, i.e. 165mm long, 25mm wide and 3mm thick. The tensile testing is done by Tinius Olsen, Make 10 kN, Dual Column Table Top Universal Testing Machine. The tensile properties were measured by an electronic extensometer. The samples were tested at a crosshead speed of 0.5mm/min. Five identical test samples were tested for each percentage volume fraction and their average result was considered.

Impact Testing

The impact behavior of the Bermuda grass root fiber reinforced polyester composites were done using Tinius Olsen Impact tester and incised as per ASTM D256, i.e. 65mm long, 12.5mm wide and 3mm thick. The test piece placed as a vertical cantilever beam in impact tester is broken by a single swing of the pendulum. Five identical test samples were tested for each percentage volume fraction and their average result was considered.

RESULTS AND DISCUSSIONS

Table 2 summarizes the single fiber test results for alkali -treated and untreated Bermuda grass root fibers. For 25 identical samples, the tensile strength was calculated by the ratio of average load to an average area. By noticing the results obtained we can indicate that the 10% NaOH treatment is optimal for better properties of Bermuda grass root fiber.

Table 2: Single Fiber Test Results

Specimen condition	Mass (mg)	Length (mm)	Diameter (µm)	Area (mm^2)	Linear density (kg/m)	Unit break (N/Tex)
Untreated	4.2	122.3	199.4	0.032	0.000333	463
5%	7.9	131.2	259.4	0.056	0.000590	1623
10%	4.1	141.5	154.4	0.020	0.00029	7194
15%	4.2	136.6	192.7	0.030	0.000299	6384
20%	5.3	141.3	250.4	0.050	0.000372	2117

The deviation in the mean tensile and impact strength of Bermuda grass root fiber reinforced polyester resin is indicated in figure 1 and 2 respectively. It evidently shows that with an increase in the fiber content of the polyester matrix, the tensile and impact strength also increases. This is due to the fact that the applied stress to the composites is transmitted evenly by the polyester resin yielding a better strength. As a result, our composite bears higher load before failing in comparison with the unreinforced polyester. The increase in the mechanical behaviors of the composites is found

in 40% Bermuda grass root fiber reinforcement, i.e. at the fiber volume ratio of 0.4.

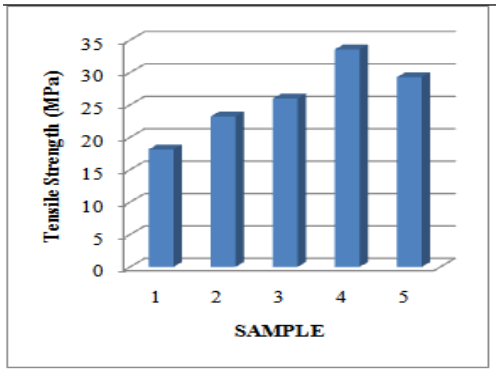

Figure 1: Tensile Behavior of Bermuda Grass Root Fiber Reinforced Polyester Composites

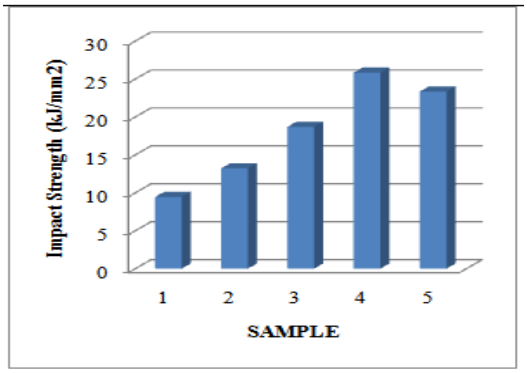

Figure 2: Impact Behavior of Bermuda Grass Root Fiber Reinforced Polyester Composites

CONCLUSIONS

This work concerns the extraction of Bermuda grass root fiber, the characterization and mechanical behavior of Bermuda grass root fiber reinforced polyester resin. The final views found from this examination are

- The alkaline treated Bermuda grass root fibers reveals greater strength compared with the untreated fibers. The 10% NaOH treated fibers yielded highest tensile strength.
- From the investigation of tensile and impact behavior, it can be accomplished that a 40% fiber volume resulted in better strength. A further increase in the volume of fiber shows a decrease in strength.
- This uniqueness suggested that this natural fiber can be a good replacement for synthetic fibers, implementing that Bermuda grass root fiber reinforced polyester composites can be used in certain applications.

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